CLAIMS

1. An apparatus for producing hydrogen from an alcohol or hydrocarbon feed, said apparatus comprising:

   (a) a reformation chamber including a feed inlet to an interior region of the chamber, a product outlet from the interior region of the chamber, and a protonic-electron conducting cermet membrane having a first side in the interior region of the chamber and a second side outside the interior region of the chamber;

   (b) a porous layer of a reformation catalyst effective to catalyze decomposition of the feed to hydrogen supported by and/or adhered to or adjacent to said first side of the cermet membrane which permits diffusion of ionic hydrogen from said first side thereof through the membrane to said second side thereof; and,

   (c) a collection region or chamber on the second side of the membrane where the hydrogen ions can be reconstituted into molecular hydrogen with a supply of electrons.

2. An apparatus according to claim 1 further comprising a heating supply system whereby the reformation chamber can be raised to and maintained at a temperature of between about 600 degrees C. to 1000 degrees C. by an integral fuel burner, said heating supply system comprising a fuel oxidizer, an electric heater, or an imported heat stream.

3. An apparatus according to claim 1 further comprising pressurizing means whereby a reformation feedstock can be compressed to above ambient pressure.

4. An apparatus according to claim 1 wherein the protonic-electron conducting cermet material consists essentially of a proton conducting ceramic phase represented generally by the chemical formula ABO_3 wherein: A is selected from the group of metals consisting of the alkaline earth metals and mixtures thereof; B is selected from an element or combination of elements from the periodic table groups of transition metals and metals in combination with an effective amount of an electron conductor metal phase additive consisting essentially of palladium, nickel, cobalt, iron, ruthenium, rhodium, osmium, iridium, platinum, titanium, zirconium, hafnium, vanadium, niobium, tantalum, copper, silver, gold, and mixtures and alloys thereof;, and, O is oxygen.

5. An apparatus according to claim 4 wherein the metal phase additive is selected so as to also function as a sintering aid.

6. An apparatus according to claim 1 wherein the reformation catalyst is selected from the group of elements consisting of palladium, nickel, cobalt, iron, ruthenium, rhodium, osmium, iridium, platinum, titanium, zirconium, hafnium, vanadium, niobium, tantalum, copper, silver, gold and alloys and mixtures thereof.,

7. An apparatus according to claim 6 further wherein the reformation catalyst is blended with an effective amount of a single-phase mixed metal oxide proton conducting material to improve decomposition, support properties, and/or hydrogen ion diffusion.

8. An apparatus according to claim 1 further wherein the catalyst layer is deposited or sintered on at least a surface of the cermet membrane to form a catalyst-membrane subassembly.

9. An apparatus according to claim 8 further wherein a catalyst-membrane subassembly is encased between a pair of metallic, ceramic or cermet containment shells in a planar configuration to form a reformation chamber element.

10. An apparatus according to claim 9 further wherein a reformation chamber element includes o-rings, seals, gaskets or brazes to effect sealing at the inner cavity edge and outer shell edge, a semi-permeable support region with an expansion foil inside the reformation chamber element, and a non-permeable parameter member that includes inlet and/or outlet manifolds.

11. An apparatus according to claim 10 further wherein a plurality of the said reformation chamber elements, each containing a catalyst-membrane subassembly in the cavity, and sealed or adhered to a containment shell to separate the reformation chamber element from a resultant chamber on the second side of the

membrane, are bonded hermetically to form a stack that is encased by a terminal shell pair.

12. An apparatus according to claim 11 further wherein the inlet manifolds of the reformation chamber elements are hermetically joined to a fuel feed and the outlet manifolds to a purged exhaust conduit.

13. An apparatus according to claim 11 further wherein manifolds associated with resultant chamber elements are hermetically joined to product gas withdrawal conduits.

14. An apparatus according to claim 13 further including a conduit system whereby a purged reformation stream withdrawn from the reformation chamber elements is diverted to a heating source where it can be combusted to produce heat for the reformation chamber.

15. An apparatus according to claim 8 further wherein a catalyst-membrane subassembly is encased in a metallic, ceramic or cermet containment chamber in a tubular configuration.

16. A method for producing hydrogen from an alcohol or hydrocarbon feed, said method comprising the steps of:

(a) contacting an alcohol or hydrocarbon feed with a reformation catalyst under reformation temperature and reformation pressure conditions

effective to decompose at least a portion of the feed into hydrogen and/or hydrogen ions and other decomposition products, said reformation catalyst being coated along or bonded to a surface on a first side of a mixed phase protonic-electron conducting cermet membrane capable of diffusing hydrogen ions;

(b) diffusing at least a portion of the hydrogen ions produced by the feed decomposition of step (a) through the cermet membrane to a second side of the membrane; and,

(c) combining hydrogen ions diffused through the cermet membrane with electrons to reconstitute molecular hydrogen on the second side of the membrane.

17. A method according to claim 16 further wherein said cermet membrane consists essentially of a material having the general chemical formula ABO_3 wherein:

A is selected from the group of metals consisting of the alkaline earth metals;

B is selected from an element or hybrid elements from the periodic table groups of transition metals and metals, in combination with an electron conductor metal phase additive consisting essentially of palladium, nickel, cobalt, iron, ruthenium, rhodium osmium, iridium, platinum, titanium, zirconium, hafnium, vanadium, niobium, tantalum, copper, silver, gold, and mixtures and alloys thereof; and,

O is oxygen.

18. A method according to claim 17 further wherein the reformation catalyst is selected from the group of elements consisting of palladium, nickel, cobalt, iron, ruthenium, rhodium, osmium, iridium, platinum, titanium, zirconium, hafnium, vanadium, niobium, tantalum, copper, silver, gold, and mixtures and alloys thereof.

19. A method according to claim 16 wherein the reformation temperature is between about 600 degrees C. and 1000 degrees C.

20. A method according to claim 16 wherein the reformation pressure is above ambient pressure conditions.